RESPONSE TO RFA # EPA-OAR-OAQPS-21-03

For:

ENVIRONMENTAL PROTECTION AGENCY (EPA)
2021 Targeted Air Shed Grant Program

Project Title: **Development, Demonstration, and Certification of 15-Liter Natural Gas Engine**

Applicant Name: South Coast Air Quality Management District
Address: 21865 Copley Drive, Diamond Bar, CA 91765

Technical Contact:
Matt Miyasato, Ph.D. — Deputy Executive Officer — Tel: (909) 396-3249 Fax: (909) 396-3252 — E-mail: mmiyasato@aqmd.gov

Aaron Katzenstein, Ph.D. — Assistant Deputy Executive Officer — Tel: (909) 396-2219 Fax: (909) 396-3252 — E-mail: akatzenstein@aqmd.gov

Joseph Impullitti — Technology Demonstration Manager — Tel: (909) 396-3252 Fax: (909) 396-3252 — E-mail: jimpullitti@aqmd.gov

Sam Cao, Ph.D. — Air Quality Specialist — Tel: (909) 396-2069 Fax: (909) 396-3252 — E-mail: scao@aqmd.gov

Administrative Contact: Karen Sandoval — Financial Analyst — Tel: (909) 396-3108 Fax: (909) 396-2765 — E-mail: ksandoval@aqmd.gov

DUNS Number: 025986159

Total Project Cost:

EPA Funding Requested	Voluntary Cost Share	Total Project Cost	Project Period
$8,000,000	$10,907,000	$18,907,000	Oct 1, 2021 to Dec 31, 2023

Project Description: This project's objective is to perform expedited development, demonstration, and certification of a 15-liter high-efficiency near-zero emissions natural gas engine for North American market made available for commercial sales for Model Year 2024 with Cummins Inc. The project deliverables include one (1) year pre-commercial demonstration of up to ten (10) Class-8 heavy-duty trucks equipped with 15-liter engine with up to five (5) different fleets that operate in South Coast Air Basin (SCAB) in drayage, regional and long-haul applications. The new 15-liter engine will be certified to 0.02 g/hp-hr Optional Low NOx Standard and comply with all new CARB Omnibus Regulation requirement for 2024. The engine will also meet the EPA 2027 Greenhouse Gas standard early and will have approximately 15% lower brake-specific CO2 emissions than the current Cummins Westport 11.9 liter natural gas engine. With rated horsepower of 525 hp and peak torque of 1,850 lbf-ft, the 15-liter natural gas engine will have similar performance to today's long-haul heavy-duty diesel engines and provide new applications for low NOx natural gas engines.

Project Location: The pre-commercial demonstration trucks will be deployed with various drayage, regional and long-haul applications fleets domiciled and operated in Disadvantage Communities in Los Angeles, Orange, Riverside, and San Bernardino Counties. The 15-liter natural gas engine will be made available for the full commercial deployment both in California and nationwide at the end of the proposed program.

Figure 1. 11.9-Liter natural gas engine pre-commercial demonstration at CR&R. (Courtesy of Clean Energy).

Workplan

The South Coast Air Quality Management District (South Coast AQMD) is submitting "Development, Demonstration and Certification of 15-Liter Natural Gas Engine" application in response to the EPA "2021 Targeted Air Shed Grant Program" (EPA OAR-OAQPS-21-03) Request for Applications (RFA) pertaining to the Los Angeles-South Coast Air Basin, CA. The South Coast AQMD is the regional air quality agency responsible for Orange and the urban portions of Los Angeles, San Bernardino, and Riverside Counties. This area of 10,743 square miles is home to over 17 million people – about half the population of the state of California. It is the second most populated urban area in the United States and encompasses over 130 cities. The South Coast AQMD has regulatory responsibility for more than 100,000 businesses operating stationary sources, of which about 30,000 have air quality permits. Despite decades of aggressive efforts to reduce air pollution from stationary sources, the SCAB continues to have some of the worst air quality in the U.S. based on the number of days the National Ambient Air Quality Standards (NAAQS) for ozone are exceeded. Currently, the SCAB, Coachella Valley portion of the Salton Sea Air Basin (SSAB), and surrounding air basins have areas in non-attainment for ozone and particulate matter ($PM_{2.5}$) In addition, the 2021 Targeted Air Shed Grant has ranked the urban portion of the SCAB (counties of Los Angeles, Orange, and San Bernardino) in the top five most polluted area relative to ozone and annual $PM_{2.5}$ standards. The most effective way to reduce air pollution impacts on the health of the SCAB's residents, including those in disproportionally impacted and environmental justice communities (EJCs) that are concentrated along the numerous transportation corridors and goods movement facilities, is to reduce emissions from mobile sources, both on-road and off-road, the principal contributor to the SCAB's air quality challenges. Consequently, the South Coast AQMD continues to work closely with the California Air Resources (CARB) and the U.S. EPA who have primary responsibility for these mobile sources.

Section 1 Project Summary and Approach

(1-A) Detailed Project Summary: The 2016 South Coast AQMD's Air Quality Management Plan (AQMP or Plan) identified the need for significant nitrogen oxide (NOx) emission reductions as the most significant air quality challenge in meeting the upcoming ozone standard deadlines. Total Basin emissions of NOx must be reduced an additional 45% by 2023, and an additional 55% by 2031 to achieve attainment. Since NOx emissions also lead to the formation of $PM_{2.5}$, the NOx reductions needed to meet the ozone standards will also lead to attainment of the NAAQS for $PM_{2.5}$. This proposed project is also consistent with the approved 2016 AQMP Measures inculding MOB-01: Emission Reductions at Commercial Marine Ports, MOB-02: Emission Reductions at Rail Yards and Intermodal Facilities, and MOB-05: Accelerated Penetration of Partial Zero-Emission and Zero Emission Vehicles. Mobile sources in goods movement sectors make up a large portion of NOx and PM2.5 emissions in the Basin and heavy-duty diesel trucks have been identified as one of the most significant sources with adverse impact on air quality and public health, particularly in Environmental Justice (EJ) communities that are disproportionately impacted by goods movement operations and activities, and result in emissions of ozone precursors, toxic air contaminants and greenhouse gases. Additionally, recent assessment of heavy-duty trucks in-use emissions show that diesel engine emissions may be higher in-use, particularly during low load and low engine exhaust temperature conditions. In order to mitigate these heavy-duty truck emissions, South Coast AQMD strongly supports accelerated deployment of zero- and near zero-emission technologies, including natural gas-fueled heavy-duty vehicles certified to CARB's Optional Low NOx Standard (OLNS). Currently, approximately 17,000 Class 8 diesel drayage trucks operate in the SCAB region, with more long-haul interstate commerce Class 8 diesel trucks, and many operate within or adjacent to EJ communities. Incentive funds are replacing diesel fleets with these NZE engines, reducing toxic diesel exhaust along with NOx and PM emissions. In California around 75% of transportation natural gas comes from renewable sources such as landfills and dairy digestors.

Past Efforts on Advancing Low NOx Natural Gas Technology: South Coast AQMD has always been at the forefront of technology, using innovative and unique approaches to reducing NOx emissions from heavy-duty diesel trucks and other mobile sources that contribute to Southern California's ongoing ozone challenges. With limited authority over mobile sources, South Coast AQMD has created programs to support the development and deployment of cleaner technologies that reduce criteria pollutants and toxics. The agency's forward-thinking approach has led to regional action and national recognition including the adoption of public Fleet Rules in 2000 and successfully defending a challenge in the U.S. Supreme Court (2005).

Evolution of the Near Zero Emission (NZE) engine began in 2003 with a joint project between South Coast AQMD, the California Energy Commission (CEC), the U.S. DOE and the National Renewable Energy Laboratory to advance development of heavy-duty natural gas engines. The result was the Cummins-Westport, Inc (CWI) 8.9-liter engine that certified to 0.2 g NOx/bhp-hr, three years before the mandated 2010 national standard. At the same time, South Coast AQMD leveraged government and private funding to deploy vehicles with these engines, expand regional fueling infrastructure, and establish a forum for stakeholders to discuss and collectively address implementation issues. In 2013, recognizing the need for accelerated NOx reductions in the heavy-duty sector, South Coast AQMD, CEC, and SoCalGas issued a joint solicitation to develop and demonstrate a NZE engine for commercial use. The result was the commercially available CWI 8.9-liter natural gas engine (L9N), the first of its kind. Additional projects with CEC, SoCalGas and Clean Energy produced the CWI 11.9-liter NZE engine (ISX12N) certified in 2018 for port fleet operations, also first of is kind, including a 20-

truck demonstration project shown in Figure 1. Local ports subsequently designated the ISX12N as fully commercial, providing technological support for state and federal agencies to establish lower heavy-duty engine standards. To date, there have been over 30,000 NZE engines deployed nationally as a result of these efforts.

Continued development of this work led to sustainable outcomes including the accelerated turnover of diesel engines to NZE, reducing toxic and criteria pollutant emissions, helping Environmental Justice (EJ) communities, and addressing landfill diversion and GHG objectives. Approximately 17,000 Class 8 diesel drayage trucks operate in this region, many within or adjacent to EJ communities. Several incentive funding programs are replacing diesel fleets to these NZE engines. South Coast AQMD's innovative strategies resulted in the creation of clean-air heavy-duty transportation models through the development of both the L9N and ISX12N engines and paved the way for similar work. CWI developed another NZE natural gas engine, the B6.7N, exclusively for distribution in North America in 2020. South Coast AQMD's work has also spurred aftermarket Original Equipment Manufacturers to certify NZE conversion systems on medium-duty commercial trucks and buses to take advantage of the extensive network of natural gas refueling infrastructure. The use of these engines are six times more cost effective than battery electric trucks and have expanded in California with growth in infrastructure, and more recently to the rest of the nation. To further seek NOx reduction on national level, in 2016, South Coast AQMD along with 20 other air quality agencies together petitioned the EPA for a national low NOx rule. In 2020, EPA released Noticed of Proposed Rulemaking to align national low-NOx standard with CARB in 2027.

Need for Proposed Technology: Cummins also recognizes the critical need to reduce NOx emissions, particularly in Extreme Non-Attainment Areas, as expeditiously as possible. Cummins has offered a 11.9-liter natural gas engine since 2014 targeting day cab applications in the less than loaded (LTL) or urban return to base operations. Since the launch of this product over 1400 fleets across the US have evaluated and, in many cases, adopted this product to move goods to evaluate the clean alternative technology and contribute to corporate or government Environmental Sustainability Governance goals. Although the existing 11.9-liter natural gas engine has performed well in the market, engines with larger displacement (13-15-liter) are typically used in long-haul operations and engines in this size category with near zero emission certified levels have not been commercialized. One of the key desires of fleet operators is for a near-zero engine with more horsepower and torque when compared to a diesel counterpart, especially for fleets with heavier pay-load and routes leading outside of SCAB. A 15-liter displacement near-zero natural gas engine with horsepower in the range of 525 hp and torque in the range of 1,850 lbf-ft, would remove the power concern barrier expressed by fleet operators. This provides for long-haul applications and the ability to haul heavy load applications with Gross Vehicle Weight Rating (GVWR) greater than 80,000 lbs. This larger engine provides the power and torque needed to go over the large mountain grades leading outside of SCAB and perform at high altitude. These applications are where the current 11.9 liter is under powered to be considered an option. Further, the new 15-liter engine is expected to fit needs of smaller fleets and independent operators that require their trucks to fit in all applications including long-haul and heavy load. At the same time, those types of applications that require high power/torque levels are also the applications where zero emission technologies and supporting infrastructure will take longer to become commercially available.

In August 2020, CARB adopted the Omnibus Low NOx Regulation with lower NOx standard phasing-in starting 2024. The regulation also included a low-load cycle (LLC), new in-use testing requirement, warranty, as well as longer full useful life (FUL) requirements. Not only will the proposed 15-liter engine be able to meet the OLNS but is also more robust in complying with the more stringent requirement of Omnibus regulation. Although the diesel combustion technology is also expected to also improve due to these regulations, the 15-liter natural gas engines are still expected to bring lower NOx and GHG emissions sooner that will benefit the SCAB (see emission reduction summary in section 3-B). Amid urgent need for additional emissions reduction to meet 2023 and 2031 deadlines, on May 7th 2021, South Coast AQMD Governing Board enacted and adopted Rule 2305 - Warehouse Indirect Source Rule – Warehouse Actions and Investments to Reduce Emissions (WAIRE) Program. This regulation will require warehouses greater than 100,000 square feet to directly reduce NOx and diesel PM, or to facilitate emission and exposure reductions of these pollutants via near-zero and zero emission trucks and equipment. Compliance Milestone for Rule 2305 and Rule 316 will begin as soon as July 2021 will create additional demand for NZE natural gas trucks in SCAB.

Need for Federal Funds: Meanwhile, the focus on urgent need for reducing near-term criteria emission in SCAB from California state agencies have quickly shifted. Governor Newson introduced Executive Order N-79-20 requiring 100% zero-emission for all mobile sources wherever feasible by 2035 (2045 for long-haul trucks). As a direct result, CARB, CEC and SoCalGas, which are long time partners with South Coast AQMD on advancing NZE technology, have all shifted their research priorities to zero-emission technology Thus, EPA support is urgently needed to continue to provide NZE engine availability and get much needed early emissions reductions. The timeline of this project is ambitious, and the requested federal funding is essential to its success. **Simply put, this project cannot happen without the requested federal funds**. The match funding that the project partners have committed are substantial, but they do not have the resources to implement expediated development without the support of additional federal funds given the complexity developing the new engine to new regulation requirements. Without federal funds, it will likely take years for Cummins to identify and

secure the funding necessary to introduce the 15-liter, likely beyond 2027 where the current opportunity to get additional emissions reduction toward 2023 and 2031 attainment goals in SCAB will be lost. Application of federal funds via this grant request will allow Cummins (and supporting fleets) to immediately deploy this impressive newer and heavier-duty engine not only for short-haul and drayage but also for long-haul and intrastate trucks that only diesel engines are currently available. With long-haul trucks, the 15-liter project benefit will be realized beyond SCAB to the entire state and throughout the nation.

Figure 2. M15N natural gas engine currently in limited production in China.

Project Detail: Cummins has a new 15-liter natural gas engine called M15N in limited production in China today (Figure 2).The new M15N offers several advantages over today's natural gas engines such as a diesel like flat deck cylinder head that has optimized cooling for natural gas specific combustion as well as lower engine mass. However, there is extensive work needed to bring this engine to the US market, this includes: 1) US vehicle chassis design is very different than in the China market, so several components will need to be modified to fit into US chassis.;2) China vehicles are 24V and US are 12V, so a few electronic components that are not 12V capable will need redesigned or re-sourced; 3) China does not follow US Emissions Standard; thus extensive emissions development work will be needed to meet CARB's OLNS and a new aftertreatment catalyst design might be required; 4) CARB also requires different and more stringent Onboard Diagnosis (OBD) than in China so most of the OBD work will have to be redone, and 5) as part of the CARB Omnibus longer FUL requirement, depending on approval, Cummins might need to run an official OBD demo test and DF test for this engine. These tasks are both costly, and time consuming. With help of federal funds, Cummins can prioritize this project and expedite the development and can be expected to launch this engine for production sales in 2024, perhaps even sometime in late 2023.

Hardware Development: Cummins has already performed preliminary packaging changes necessary to fit the M15N engine in US chassis. Seven specific chassis models have been reviewed in CAD and summary is presented below. Intake manifold, EGR cooler, after-treatment, valve cover, and turbo has have been flagged as show stoppers which requires re-engineering. Cummins will also work with OEM's for vehicle level modifications but Cummins expects most of the changes will need to be on the engine side. For the after-treatment, Cummins might have to move it off of the engine which could require a larger catalyst or more precious metal and added cost. The intake manifold and EGR cooler are all large items that require aditional resournces to develop. Cummins has also identified at least 3 electronic parts that are not 12V capable. The ignition and fuel injector control module will need to be re-engineered for 12V. Cummins was provided a preliminary quote from the ignition module supplier for $100k to do this work. The crankcase ventilation motor and engine brake solenoids will need to be re-sourced. There are over 60 customer tailoring options that will need to be redesigned, reconfigured, re-matched such as fan mounts, alternators, engine mounting brackets, oil pans, dipstick options, flywheel options, and so on. In order to fast track development 15-liter project for U.S. 2024 launch, Cummins plans to leverage its Cummins China engineering resources for part of the hardware development task since the engine was designed in China.

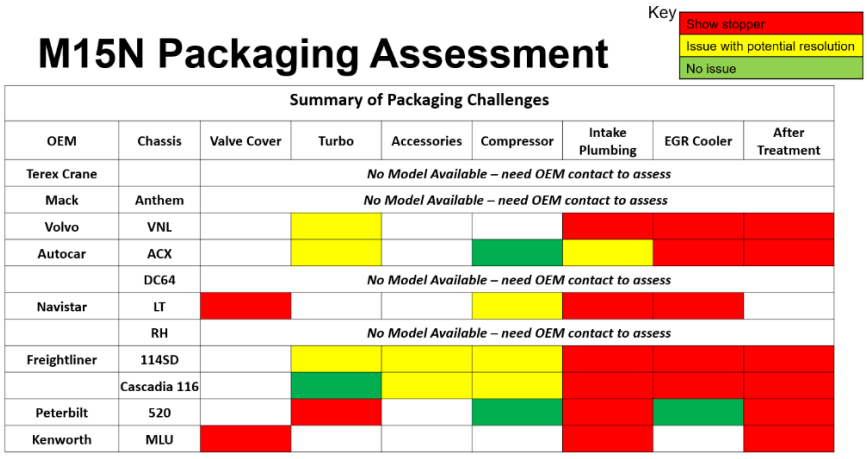

Figure 3 M15N preliminary packing assessment with North American truck chassis.

Emissions/OBD Development, Demonstration, and Certification: From an emissions standpoint, the engine is currently certified to meet China's NSVI emissions (similar to Euro VI). The engine will need to be re-calibrated to meet CARB's 2024 OLNS 0.02 g/hp-hr emission target. The 15-liter engine architecture is similar to today's 11.9-liter engine and is definitely capable of meeting 0.02 g/hp-hr NOx standard. The engine does have some minor improvements over the 11.9 L to reduce pumping losses in the air handling and EGR system, reduce frictional losses, some combustion chamber improvements, and air/fuel ratio control improvements. Cummins expects a 15% brake-specific CO2 improvement compared to 11.9-liter engine. Moreover, NSVI does not target low NOx emissions, thus the air/fuel ratio control strategy will need to be biased a little richer and fine-tuned to minimize NOx emissions for the US market. Special attention

will be given to cold start operation and fuel cut (motoring) events to minimize NOx spikes related to these conditions. Most of the emissions development work will be done with aftertreatment that is aged to FUL. Vehicle level in-use emissions testing will be required to make sure the engine meets the new 3 bin MAW (Moving average window) in-use test requirements. A software or hardware solution will need to be determined to make sure the compression release engine brakes will be compliant to the in-use test requirements as well. Typical use of the engine brakes requires the intake throttle to be wide open to have sufficient of air flow for compression braking. This excess air cools off and oxidizes the catalyst which are both bad for NOx emissions. Some areas of investigation for this include catalyst formulation changes, exhaust insulation, exhaust throttle, and changes in air/fuel ratio control and spark timing after the braking event. Obtaining 0.02 g/nhp-hr NOx will also require implementing strategies to improve NOx during cold start. These strategies were not necessary for NSVI but are well understood from the 11.9-liter engine. Cummins also expects to leverage its global resources and run test cells in parallel in both U.S. and in China for the emissions and OBD development work in order to fast rack this project.

Table 1: Proposed MY 2024 M15N Specifications.

Specification	MY 2024 M15N
Numbers Included in Project	10 demo + commercial sales
Weight Class	GVWR up to 100,000 lbs.
Power	430-525 hp
Torque	1550-1850 lbf-ft
NOx Target	0.02 g/bhp-hr OLNS
CO2 Target	15% better BSCO2 than X12N
Fuel Type	CNG/RNG
Fuel Capacity and Range	Up to 295 DGE or 1,700 miles
North American **Vehicle OEM Availability**	Terex Crane, Mack, Volvo, Autocar, Navistar, Freightliner, Peterbilt, Kenworth

There are well over 200 OBD monitors that will all need to be revisited for the U.S. market. Some of these just need to be reviewed to confirm that their operation meet U.S. requirements while others will need retuned to meet US OBD requirements or because the emissions recipe will be adjusted. There are also some new monitors for this engine such as O2 sensor sufficiency and cylinder imbalance that are not necessary for NSVI. The requirements for these are mostly well understood from the 11.9-liter engine but use of a wideband O2 sensor instead of a switching O2 sensor for the primary O2 sensor will require some changes.

U.S. emissions certification process includes pre-certification activities to make sure the engine is ready for cert test. Cummins generally tests at least 3 engines to ensure the engine is ready for certification. The cert test will include FTP, RMCSET, LLC, and GHG cycles. An official CARB OBD demo will be required that includes a long engine break-in period. It is possible that a separate Deterioration Factor (DF) test could be required as well. Cummins will need to purchase certification fuel for the emissions cert test and the OBD demo. Even though endurance tests have already been completed for the engine for China, it is likely that a couple of these tests will need to be repeated due to new hardware introduced for the US market. All pre-certification and certification work will be performed in U.S.

Pre-Commercial Demonstration: Cummins application engineering team will need to work with field test location to engineer the pre-production 15-liter engine into these vehicles for the pre-commercial demonstration portion of this proposal. Cummins will repower up to ten (10) used trucks with the M15N pre-commercial engine. Cummins will provide the engines and aftertreatment systems for the vehicles to be retrofitted. Extra support and special vehicle modifications will be needed early on if the engine design changes are not fully completed. If this is the case, the engines will be upfitted with the new hardware as it becomes available. Cummins plans to field test at least 10 vehicles with actual fleet customers in SCAB region as well as up to 5 additional vehicles with fleets across the US. Most of the vehicles will be equipped with dataloggers which Cummins engineers will regularly review to look for any signs of engine calibration or hardware issues. The summarized trip statistics will be analyzed and presented in the monthly and quarterly update. The dataloggers will also be used to help with the development of US OBD calibrations to make sure they have good IUPR (in use performance ratio) and that the OBD calibrations have appropriate margins. The demand for a 15-liter near-zero engine is anticipated to grow substantially due to historical air quality needs but also due to an increasing number of companies with more aggressive sustainability goals and requirements.

(1-B) Analysis of Emissions Inventory: Detailed inventory analysis can be found in the emissions inventory attachment. According to the 2020 CARB Mobile Source Strategy (MSS) and 2016 State Implementation Plan (SIP), heavy-duty trucks stills makes up nearly 1/3 of mobile source NOx emissions and account for 20% of Ozone precursors and $PM_{2.5}$(Table 3 in attachment 6-A). At the same time, as presented in Figure 4, even with all state and federal regulations, additional NOx reductions will be needed to reach attainment with limited reductions for 2023 and 2031. The 15-liter project is poised to deliver substantial emission reduction benefits through the deployment of 10 pre-commercial demonstration trucks and as well as the sales of the new 15-liter natural gas engine once it's available for commercial deployment by end of 2023. Section 3 presented the detailed breakdown, but when combined together, as shown in Table 3 below This project will directly facilitate the reduction of NOx emissions in the region by 84.72 ton per year on average or 847.22 tons over 10-year period. Further, as CARB's Low Carbon Fuel Standard (LCFS) continue to phase in, the use of renewable natural gas

(RNG) with lower carbon intensity is expected to increase the GHG reductions via use of RNG by at least three-fold compared to fossil CNG.

As presented in Section 3, over 98% of NOx reductions come from future deployment of the 15-liter engine once it's available for commercial sale starting in late 2023, if the project is awarded. With proven technical and economic success of these units from past natural gas engines and demonstration effort, this project will generate tremendous market interest which will quickly translate into thousands of tons of emission reductions throughout California and nation wide. The project team has heard requests from port drayage operators, large national retail store companies, large national less than loaded truck fleets, fuel haulers, contract US mail carriers, owner operators and more asking for a 15 liter natural gas engine that gives them the performance they enjoy today with their 15 liter diesel engine products.

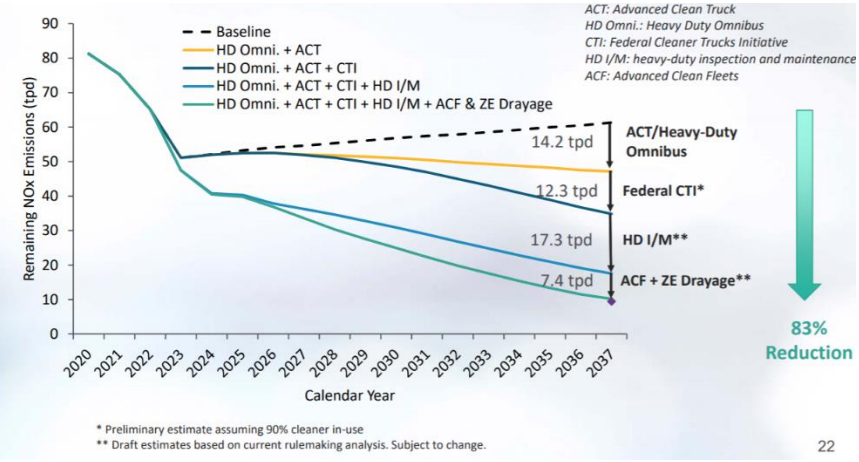

Figure 4: CARB estimated NOx reductions from various regulations.

(1-C) Consideration of Activities: The project team has considered the full range of alternative fuel technologies, before deciding to pursue a near-zero emissions engine development project, mainly due to it being an innovative and cost-competitive option. There have been decades of investment in natural gas engine technology, infrastructure, and development of RNG. Natural gas engines fueled by RNG are 100% petroleum displacement strategy that dramatically reduces smog-forming, cancer-causing diesel emissions as well as global warming emissions. Those living in low-income, minority or distressed areas are more likely to be paid on an hourly basis and cannot afford to take days off from work due to respiratory illness, asthma attacks, and other sicknesses. Further, they cannot compound this with added medical expenses. Reducing emissions will reduce incidences of respiratory illness, loss of workdays and by extension financial hardship. A natural gas truck fueled by RNG has 90% fewer NOx emissions, 15-50% lower GHG emissions, 100% fewer SOx emissions, and 100% less petroleum diesel consumption compare to diesel. Thus, a combination of zero-emission and near-zero emission technologies will be needed to achieve the required 45% and 55% NOx emission reductions to meet the 2023 and 2031 federal standards. South Coast AQMD assessed emission reduction potential of three available Class 8 heavy-duty vehicle strategies that are suitable for long-haul and intrastate operation. The first strategy considers the baseline case of conventional MY 2010+ diesel as required by the CARB Truck and Bus Regulation. Although these engines are certified to 0.2 g/bhp-hr NOx standard, the in-use emissions are proven to be much higher due to low-load urban operation and low SCR efficiency, such as those found in typical drayage and regional haul operations. Moreover, the missed opportunity on this round of fleet turnover means these diesel trucks will be in service for many more years before needing replacement. Furthermore, the lower NOx standard phasing-in starting in 2024 might lead to a massive pre-buy of 0.2 g/hp-hr trucks prior 2024 as diesel engines are anticipated to become more complex. The second strategy involves replacement with zero-emission battery-electric or hydrogen fuel cells trucks. Although this strategy will result in 100% NOx and $PM_{2.5}$ reduction. As part of South Coast AQMD on-going project learnings, the zero-emission technologies are limited by higher initial costs and lack of supporting infrastructure which limits the application to short haul and drayage. CARB and CEC have placed research focus on developing additional public infrastructure along the freight corridor but mass availability of these trucks or infrastructure in near-term is unlikely. The final strategy is to replace diesel with near-zero emission natural gas trucks. This strategy will achieve most significant near-term NOx emissions reductions in SCAB, and fits into South Coast AQMD's air quality goals and will help to increase market share of near-zero-emission trucks in long-haul applications. This 15-liter near-zero engine would specifically target applications and duty cycles where zero-emission technologies will take longer time to be commercially available and provides a much lower emission alternative to diesel. As a result, NZE natural gas technology is complementary to the zero-emission efforts currently

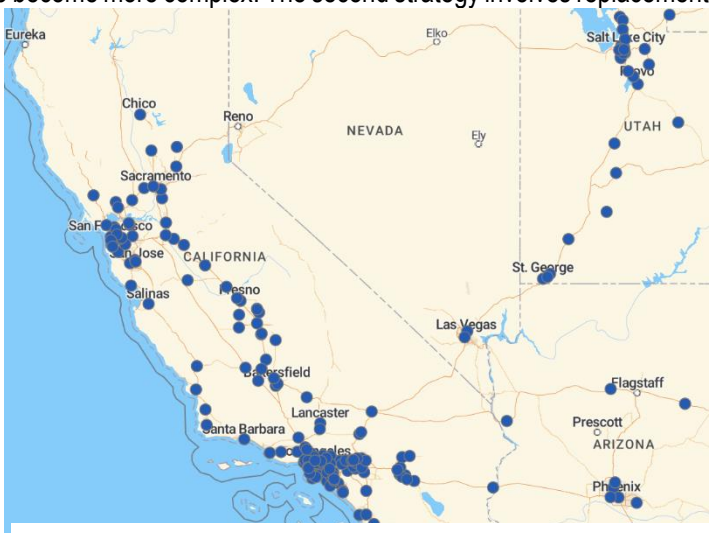

Figure 5: Existing Public CNG Refueling Stations in California and Surrounding Regions.

underway. Moreover, with a successful pilot demonstration of the 15-liter engine with partners like TTSI, Walmart, UPS, Matheson and Kroger will provide a range of natural gas truck engines well suited for both short and long-haul applications across varying duty cycle requirements. It will also facilitate a secondary market that will allow used truck buyers to have confidence the vehicle will meet their operational needs. Another major advantage of the NZE natural gas truck is its extensive refueling network. According to DoE's Alternative Fuels Data Center, there are over 900 public CNG refueling stations nationwide, with nearly 170 located in California, see Figure 5. The public stations in California are already well placed along the freight corridors for long-haul applications proposed in this project, many of them located in and adject to disadvantage communities. As specified in Table 1, an M15N natural gas-powered long-haul tractor equipped with an available 295 diesel gallon equivalent (DGE) tanks should have an estimated range of 1,700 miles, fully capable of both intra-and interstate freight movement. The longer range and existing refueling stations allow the emissions benefit from the 15-liter to go beyond SCAB to surrounding air basins. One strategy that's not mentioned here is the low NOx diesel technology, since the technology is still in development and early demonstration stage and the timeline does not meet urgent NOx reduction needed at this time. Both the 0.05 and 0.02 g/bhp-hr NOx diesel engines have been used as baseline case for the purpose of calculating emission reduction, see attachment for details.

(1-D) Progress Towards Attainment: Detailed inventory analysis as well as emission reduction calculations can be found in attachment 6-A and 6-B. For this project, petroleum diesel fuel displacement is presented as GHG emissions reductions to better show the emissions reduction due to lower carbon intensity of the CNG. No $PM_{2.5}$, CO, and VOC emissions reductions are considered as Carl Moyer Grant Calculator only considers NOx reduction for 0.02 g/bhp-hr technology. As discussed in detail in section 3B, both the 10 demonstration trucks and estimated new 15-liter sales are considered for NOx and GHG emissions reduction purposes. As presented in Table 3 below, this project will provide tremendous annual and lifetime emission reductions towards attainment as well as to the benefit of the surrounding communities. In addition to the immediate emission reductions and community engagement benefits from this deployment, this project is poised to serve as a catalyst for the accelerated penetration of near-zero emission technologies in Class 8 long-haul applications for the first time throughout the SCAB, California, and U.S. Through its Clean Fuels Fund, South Coast AQMD supports a variety of zero and near-zero emission technologies as part of its portfolio approach to achieve the required 45% and 55% additional NOx reductions to reach attainment of its national ambient air quality standards (NAAQS). As part of a longer term strategy, South Coast AQMD partners with major OEMs such as Cummins to accelerate commercial deployment of the most promising, and cost effective near-zero emission technologies in source categories that have the greatest potential to achieve significant NOx and $PM_{2.5}$ reductions, as well as greenhouse gas (GHG) co-benefits. Heavy-duty NZE trucks are important components of this strategy. This project will be complementary to all other existing efforts and the additional emissions reduction from this project will help SCAB tremendously toward its Ozone attainment goals of 2023 and 2031. Furthermore, since the 15-liter engine resulted in this project will be made available for commercial sale all over U.S. and made for long-haul applications. The project will also bring in significant reductions to non-attainment areas all over California and the U.S., the reductions outside of SCAB are presented in attachment 6-B. For the purpose of estimating emissions benefit within SCAB, a lower VMT of 50,000 miles, which is typical for short-haul and drayage application was used.

Table 3. Estimated NOx and GHG emissions reductions in SCAB.

	NOx (tons)	GHG MT CO2e, Fossil CNG	GHG MT CO2e, Biomethane CNG
Annual (averaged)	84.72	107,255	362,245
Lifetime (2022-2031)	847.22	1,072,553	3,622,451

This project will also directly support the EPA's Strategic Plan. South Coast AQMD and its project partners created its scope with the sole purpose of reducing emissions using new technologies that allow the same mode of operation without using diesel fuel. This project directly supports EPA's Strategic Plan - Goal 1, Objective 1.1: "Improve Air Quality" by directly improving the air quality where millions of Southern Californians live and work. Given that the South Coast Air Basin has exceeded the established standards for healthy air on numerous documented occasions, this project puts South Coast AQMD in partnership with the EPA to support the attainment of the NAAQS by way of deploying large number of NZE vehicles. The project will result in the direct reduction of NOx, ozone, and particulate matter and will enhance the market for clean fuel technologies, especially for Class 8 long-haul applications which is solely served by diesel trucks today.

(1-E) Roles and Responsibilities of South Coast AQMD and Partners: The project team has extensive experience working together, and each team member's role, personnel, and responsibilities are outlined in Table 4. As described in section 1-A, South Coast AQMD's experience with Cummins in natural gas low NOx engine development spans almost two decades. More recently, the collaboration has expanded to hybridization as well as zero emission hydrogen fuel cell. In this proposed project, Cummins is taking the next step in natural gas technology by offering low NOx natural gas engines for its complete product line with a larger scale commercial deployment of Class 8 long-haul natural gas trucks in the U.S. market for the first time.

Table 4. Role and Responsibilities.

Organization	Role	Key Personnel	Responsibilities
South Coast AQMD	Grantee; project administration	Matt Miyasato, Aaron Katzenstein, Joseph Impullitti, Sam Cao, Karen Sandoval	Grantee: Project administration and oversight, project planning, contract management, budget and payment tracking and oversight, reporting, data collection and submission oversight.
Cummins Inc.	OEM; project management, data collection	Scott Baize, Tom Swenson, Hugh Donnelll, Tom Hodek	Engine OEM; customer sales and manufacturing support. Launch commercialization and deployment for 15-liter CNG engines. Capture fleet performance data and prepare analyses
TTSI	End Use Fleet Operator / Site Owner	Vic LaRosa, Tony Williamson	Operate demo trucks, provide end user feedback, support any access and testing of trucks
Kroger	End Use Fleet Operator / Site Owner	Dan Umphress	Operate demo trucks, provide end user feedback, support any access and testing of trucks
Walmart	End Use Fleet Operator / Site Owner	Jeff Byrne	Operate demo trucks, provide end user feedback, support any access and testing
Matheson Trucking	End Use Fleet Operator / Site Owner	Daniel Shandy	Operate demo trucks, provide end user feedback, support any access and testing
UPS	End Use Fleet Operator / Site Owner	Anthony Marshall, Dennis Elford	Operate demo trucks, provide end user feedback, support any access and testing
Athens Services	End Use Fleet Operator / Site Owner	Marty Mitchell	Operate demo trucks, provide end user feedback, support any access and testing

South Coast AQMD selected Cummins as its partner because of its: 1) expertise and experience in manufacturing and deploying quality Class 8 powertrains; 2) ability to secure participation letters from fleet customers to deploy the natural gas trucks; and 3) cost share committed to the project. Cummins has already convened thirty of the region's largest commercial fleets and the local utility to discuss this truck deployment opportunity. Six fleets have committed to demonstrating the new 15-liter natural gas trucks, two of which were involved in the previous 11.9-liter natural gas demonstration project. Cummins and South Coast AQMD have received tremendous interest from other fleet partners, and more than 60 well-known companies and current Cummins customers have expressed interest in the 15-liter natural gas engine. Following a project kick-off, Cummins, and South Coast AQMD will finalize the selection of more fleets including owner operator fleets based on potential impact to DACs, alignment with the fleet's corporate sustainability goals, financial capabilities, and community engagement plans amongst other factors. Lastly, for outreach to the communities impacted by the project, South Coast AQMD and Cummins will together advocate the near-team emissions benefits of natural gas trucks.

Section 2 Environmental Justice

(2-A) Environmental Justice Issues and Environmental Health Disparities: EJ communities (EJCs) have long been a focus of the South Coast AQMD. In 1990, the South Coast AQMD formed an Ethnic Community Advisory Group that was restructured as the Environmental Justice Advisory Group (EJAG). EJAG's mission is to advise and assist South Coast AQMD in protecting public health in South Coast AQMD's most impacted communities through the reduction and prevention of air pollution. The SCAB contains numerous communities experiencing disproportionate environmental impacts, including the Port communities that will directly benefit from the operation of proposed NZE technology. The purpose of South Coast AQMD's EJ program is to ensure that everyone has the right to equal protection from air pollution and fair access to the decision-making process that works to improve the quality of air within their communities. The project includes facilities from the confirmed fleet partners that are domiciled or operated in EJCs. According to CalEPA's CalEnviroScreen (CES) 3.0 mapping tool, the location of the fleet bases in SCAB are all located in EJCs that rank higher than 90th percentile in terms of pollution burden. This tool aggregates pollution and population data to score community burdens. Note that all the fleets operate in the surrounding regions which include many EJCs as shown in Figure 6 and the vehicles that travel from the site

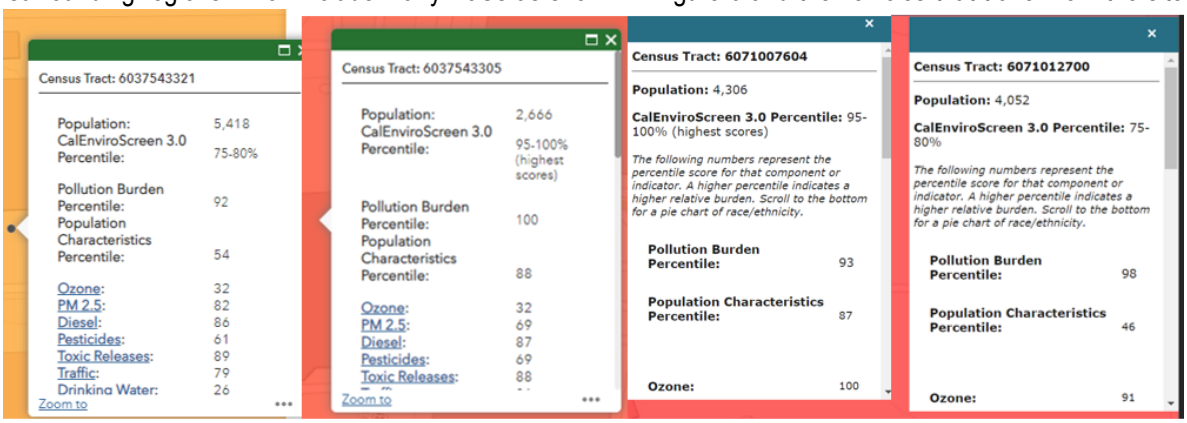

Figure 6: Left to right Kroger, TTSI, Matheson Trucking and UPS's CalEnviroScreen 3.0 Metrics.

operate heavily in EJCs. EJCs near this project will benefit from the immediate reductions in diesel emissions, increased community engagement with local businesses and residents, and the long-term benefits of NZE technologies. This year, the three AB 617 communities in the SCAB are beginning implementation of measures included in their CERPs using Community Air Protection (CAP) Funds. The goals of the AB 617 program are also consistent with South Coast AQMD's Environmental Justice Program to protect and improve public health through the reduction and prevention of air pollution.

Table 5. EPA EJSCREEN and CalEnviroScreen 3.0 Metrics

Fleet Name	Address	Application	DAC	CES 3.0 Pollution Burden %ile	EJSCREEN PM2.5 %ile	EJSCREEN Ozone %ile	EJSCREEN Demographic Index %ile	EJSCREEN Minority Population %ile
Kroger	2201 S Wilmington Ave, Compton, CA 90220	Regional-Long-Haul	Yes	92	97	50	83	92
TTSI	18735 S Ferris Pl, Compton, CA 90220	Drayage, Regional-Haul	Yes	100	97	47	78	88
Walmart	10815 State Hwy 99, Red Bluff, CA 96080	Regional-Long-Haul	No	N/A	30	89	51	50
Matheson Trucking	27356 W 5th St, Highland, CA 92346	Drayage, Regional-Long-Haul	Yes	93	93	99	82	82
UPS	3140 E Jurupa St, Ontario, CA 91761	Regional-Long-Haul	Yes	98	99	99	94	98
Athens Services	14048 Valley Blvd, La Puente, CA 91746	Regional-Haul	Yes	100	98	95	87	94

The Census Tracts that houses the fleet locations in this project are all in over 90 percentile of pollution burden in California per CES. TTSI's operation in Southern California services the Port of Los Angeles (POLA) and Port of Long Beach (POLB) and include warehouse operation in Compton, CA approximately 14 miles from the POLA and 11 miles from the POLB. Both fleets were prior participants of the 11.9-liter demonstration and expressed interested in the 15-lilter. Likewise, every single neighborhood that the trucks traverse in order to move goods to and from the port are either in the 98th, 99th, or 100th, percentile of pollution burden. Specifically, Census Tract 6037543305 that houses the TTSI facility suffers largely from particulate matter (PM) 2.5 (69th percentile) and DPM (87th percentile). The most direct route for deliveries from the TTSI warehouse to the inland empire is at least 45 miles and over 90% of it traverses DACs. This project mitigates the negative health effects of goods movement¬–related air pollution along the I-710 corridor. The impacted region of the I-710 corridor that connects the San Pedro Bay Ports to distribution centers traverses SB 535 DACs and AB 1550 Low-income Communities from origin to destination. The I-710 gets more than twice the Los Angeles freeway average of truck traffic. Infamously named the diesel death zone, this region alone accounts for 20% of all particulate emissions in Southern California. Caltrans reported annual averages in 2017 showing that more than 20,000 trucks pass through sections of this freeway each day, and LA Metro predicts this traffic will more than double by 2035. Seventy seven percent (77%) of residents identify as either African-American or Hispanic compared to 56% of LA County households. These DACs are at greater risk of developing asthma and experiencing poor health conditions, hospitalizations, and early death from exposure to DPM from goods movement activities. This project will also significantly reduce GHG, criteria, and toxic emissions (NOx, SOx and DPM) in neighborhoods, San Pedro Bay Ports, I-170 corridor and Inland Empire, providing important public health benefits for DACs through the other fleet partners in this project. Matheson Trucking's Highland depot (Census Tract 6071007604) location also serves the ports but also operate other regional and long-haul applications within California. Kroger operates out of the Compton location (Census Tract 6037543321, CES 3.0 92% Burden) to a network of distribution centers that serves all the grocery locations throughout the SCAB. UPS will operate out of their Ontario regional hub (Census Tract 6071012700, CES 3.0 98% Burden) attached to Ontario International Airport. Walmart's Red Bluff location is not located in a DAC but this location is the Walmart and Sam's Club's California operations hub serves other California distribution centers including SCAB. Walmart plans to use the demonstration trucks for both regional within SCAB and intrastate long-haul operation. Athens Services (Census Tract 6037408202) is a waste collection service which already operate a CNG fleet and will use the 15-liter to transport wastes to landfills. A successful demonstration project will showcase to the drayage, regional, and long-haul industry the feasibility and benefits of Class 8 natural gas trucks and provide the impetus for many more logistics stakeholders to follow suit. California's policymakers will have a prime example to encourage further investment in near zero-emission goods movement technologies, and residents will witness tangible investments in their communities.

(2-B) Community Engagement: The EPA, CARB, the San Joaquin Valley Air Pollution Control District, and South Coast AQMD established the Clean Air Technology Initiative (CATI) Program to identify and implement projects that would significantly reduce

emissions in communities like the cities of San Bernardino, Long Beach, and Los Angeles. Since the creation of CATI Program in 2010, South Coast AQMD has organized several public workshops with public and private fleets, and community members such as Los Angeles Councilmember Jose Huizar's field deputy David Miranda, Monsignor John Moretta of the Resurrection Parish, and others to identify and develop community-specific solutions to air quality issues in areas disproportionately affected by air pollution. These workshops have produced eight air quality projects ranging from diesel truck replacements, railyard studies, air toxics studies, school bus replacement, locomotive replacements, as well as drayage truck replacements starting from 2010 to 2017.

This newly proposed project is a product of these successful past development, demonstration and deployment projects. As follow-on to this project, South Coast AQMD will partner with U.S. EPA, CARB, CEC, and Ports of Los Angeles and Long Beach to further incentivize replacement of older and dirtier diesel delivery trucks with purposely built near-zero emission trucks like the ones in this study. There are also community meetings and implementation activities from South Coast AQMD's implementation of the AB 617 program for the San Bernardino/Muscoy community, which also benefit the surrounding communities of Ontario, Chino, and Fontana in San Bernardino County. Many of the community meetings for the AB 617 program focus on communicating the benefits and challenges with implementing near-zero emission technologies in freight handling facilities in and around San Bernardino. This meeting raised awareness for South Coast AMQD's pathways to obtain needed emission reductions and public exposure in those communities. Based on these previous experiences, South Coast AQMD and Cummins together with participating fleets will utilize the existing channels to further engage the communities especially EJCs, such as the Advanced Clean Transportation (ACT) Expo and public news releases. Further, South Coast AQMD will collaborate with Cummins to garner support of major fleets who will help accelerate adoption of near-zero emissions Class 8 long-haul trucks in California and throughout the U.S. Fleets must understand how the NZE trucks will be able to perform the same as diesel trucks and generate emissions benefit to the communities. This is critical to overcome the barriers in order to catalyze penetration the NZE trucks in the marketplace, especially for smaller fleets and independent operators that require a vehicle that can perform in a wide-variety of applications. South Coast AQMD has been and will remain diligent to work with State and Federal Regulatory agencies to push for early, meaningful, and cost effect emissions reductions for our communities. South Coast AQMD has sent in multiple comment letters to CARB and EPA and publicly testified the urgent need for emissions reductions now in SCAB, and NZE are one of the important pathways towards attainment.

Section 3 Environmental Results – Outputs, Outcomes and Performance Measures

(3-A) Expected Project Output and Outcomes: With the introduction of 15-liter natural gas trucks in the SCAB by 2024, the expect total emission benefits from using natural gas in-lieu of diesel trucks over 10-year project life is estimated Table 6 below. The proposed project will lead to immediate and on-going improvements in regional air quality and human health, as well as other societal and economic benefits, particularly in locations where the residents are disproportionately impacted by diesel truck emissions along the numerous traffic corridors. More details of the emissions reduction calculation and assumptions can be found in section 3-B and attachment 6-B. South Coast AQMD fully anticipates additional deployment vehicles once the project is awarded, as many of the patriating fleets that indicated the need for higher power natural gas trucks will consider switching.

Table 6: Anticipated Outputs and Outcomes for averaged Annual and Lifetime between 2022 and 2031 in SCAB.

Outputs	Outcomes			
Emissions Reductions		**NOx (tons)**	**GHG (MT CO2e for fossil CNG)**	**GHG (MT CO2e for biomethane CNG**
Repower 10 0.2 diesel fueled 0.2 Class 8 trucks with 0.02 NG engine	Annual	1.35	143	484
	Lifetime	13.53	1,434	4,844
Deploy 5,334 new 0.02 NG Class 8 trucks in-lieu of 0.05 diesel trucks (2024-2026)	Annual	83.37	52,915	178,715
	Lifetime	833.69	529,148	1,781,151
Deploy 13,337 new 0.02 NG Class 8 trucks in-lieu of 0.02 diesel trucks (2027-2031)	Annual	0	54,197	183,046
	Lifetime	0	541,971	1,830,456
Total	Annual	84.72	107,255	362,245
	Lifetime	847.22	1,072,553	3,622,451
Cost-effectiveness, total project cost	$18,907,000	$22,316.40	$17.63	$5.22
Cost-effectiveness, EPA funds	$8,000,000	$9,442.60	$7.46	$2.21

In addition to the air quality benefits, the project will produce other outputs and outcomes including:

- **Catalyzed commercialization through large-scale demonstration**: From the lesson learned from early 8.9-liter engine, the 11.9-liter engine performed a demonstration with port fleet which enabled the commercial success of the 11.9-liter engine for drayage and short-haul applications. Cummins has a strong commitment to provide NZE for long-haul applications as well. These applications have relied on diesel engines and need to overcome barriers related to power, range, refueling availability and reliability. The

demonstration phase planned for the 15-liter will further solidify that NZE technology is fully capable for long-haul applications. Positive demonstration effort such as this one will be positive ripple effect in similar operations across the country.

- **Acceleration of widespread adoption for all fleets:** Near-zero and zero emission technologies have long been reserved for large fleets with more operating flexibilities. Small fleets and independent operators, who require vehicles to perform well in all applications where today only diesel trucks are offered. This project will overcome by far the biggest barrier to expand the use of NZE natural gas engines by offering more powerful engines which will enable boarder deployment and acceptance of the NZE natural gas technology to new end-user that pervious near-zero and zero emission technologies were not able to reach. Moreover, it creates a secondary market for owner operators who prefers the 15-lilter but at a much lower initial cost.
- **Job creation/retention:** Finally, as South Coast AQMD's and other agencies have decades long investment in natural gas technology, the jobs associated with natural gas technology will be retained and continue to expand. This project will enable ongoing workforce development, recruitment, and retention in clean advanced technologies, further stimulating the economy.
- **Application beyond short haul/drayage:** The new engine will enable additional fleets to consider natural gas NZE technology for long-haul applications. The 11.9-liter natural gas engine was targeting day cab applications in the less than loaded (LTL) or urban return to base operations. With the strong foundation from 11.9-liter, added flexibility from 15-liter and new regulatory requirement such as the recently passed South Coast AQMD WAIRE program, more fleets across the US will be adopting this product to move goods to evaluate the clean alternative technology and contribute to lowering corporate or government Environmental Sustainability Governance goals. The additional NOx and GHG emissions reduction as well as diesel fuel reduction from the deployment for California and entire U.S. are presented in the emissions reduction attachment.

(3-B) Expected Emissions Reductions: Detailed step by step emissions reduction calculation can be found in attachment 6-B. Estimated NOx, GHG emissions reduction as well as cost-effectiveness were calculated based on official methodology presented in CARB's Carl Moyer Calculator as well as in CARB's Zero- and Near Zero-Emissions Freight Facilities Project (CARB ZANZEFF) attachment. As presented in Table D-2 of the Carl Moyer Program Guidelines, 0.05 and 0.02 g/bhp-hr NOx technologies only provide NOx benefit thus no other criteria emissions benefit are presented. Since CARB's Low Carbon Fuel Standard (LCFS) highlights benefits of the use of RNG, South Coast AQMD staff also provided GHG emission reduction estimates for both fossil and biomethane CNG with carbon intensity presented in CARB ZANZEFF attachment. The GHG also shows the benefit of using CNG instead of diesel fuel, but detailed diesel fuel reduced is also in attachment 6-B.

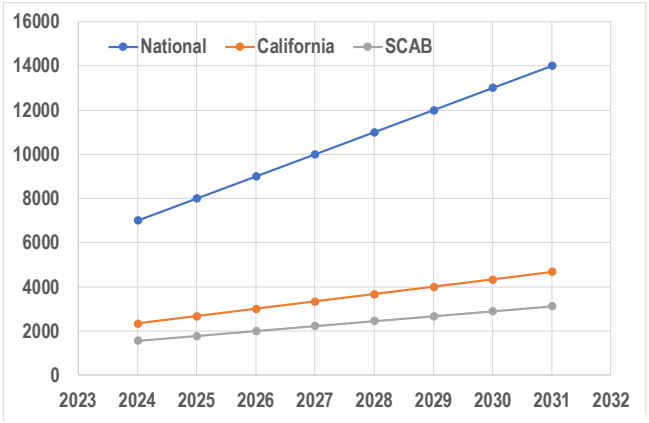

Figure 7 Projected 15-liter Sales through 2031.

As allowed in the RFA, demonstration projects such as this one can estimate future emission reductions of wider deployment after project completion. Thus, for calculation of the emissions benefits beyond the project period, Cummins has provided sales projection of the new 15-liter engine for National, California, and SCAB, see Figure 7. Cummins provided a modest estimate of 3% of total Class 8 tractor market but expects higher adoption since the 15-liter is the first near-zero emissions technology made available to long-haul truck segment. These estimated sales volumes were added on top of the 10 demonstration trucks deploying starting 2022 which are expected to remain with customer after project end. For simplicity, the emissions reduction is only calculated for 10 years between 2022 and 2031,regardless of when the estimated truck sales occurs, but estimated trucks deployed in later years are expected to remain in service for its full useful life and continue to provide emissions reductions for SCAB and beyond. For the same reason, the annualized emissions reductions are all averaged over 10 years from the lifetime totals between 2022 and 2031. For the purpose of estimating reduction within SCAB, a lower VMT of 50,000 miles, which typically for short-haul and drayage application was used. Statewide and nationwide emissions reductions are also presented in attachment 6-B. Table 7 below shows the estimated NOx reduction year over year, detailed assumptions and step by step calculation are presented in emission reduction calculation attachment. Since the EPA and CARB NOx standard is expected to reach 0.02 g/bhp-hr, no additional NOx reduction is calculated for units sold beyond 2027. But the NOx reductions prior 2026 is very significant and critical towards SCAB attainment goals.

Table 7. Project NOx reduction through 2031 for SCAB.

Ton per year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
10 demo trucks	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
2024 Sales			35.16	35.16	35.16	35.16	35.16	35.16	35.16	35.16
2025 Sales				40.18	40.18	40.18	40.18	40.18	40.18	40.18

2026 Sales					45.19	45.19	45.19	45.19	45.19	45.19
Total NOx	**847.22**									

At the same time, GHG emissions is expected to continue through 2031 and any 2024-2031 estimated deployments will continue to be in service well beyond 2031. The GHG emissions reduction is also substantial due to the lower carbon intensity of CNG and biomethane CNG. South Coast AQMD staff estimated GHG reductions for both fossil and biomethane CNG using the ZANZEFF methodology. Details are presented in attachment 6B.

(3-C) Performance Measures and Plan: Measurable annual and life-time results of this project are described in the Expected Outputs and Outcomes section above. The predicted results will be tracked against the actual results by lead project partner Cummins for both within the project period and after completion. Within the project period, South Coast AQMD will provide the EPA with quarterly progress reports and a final report, with input from project partners, on project milestones such as summarized statics of demonstration trucks deployed, engine hardware/emissions testing summaries, any challenges and delays encountered, updated timeline, funds expended, and other pertinent information based on the project timeline. South Coast AQMD utilizes the Multiple Air Toxics Exposure Study V (MATES V) to monitor and evaluate emissions in the South Coast Air Basin. South Coast AQMD gathers measurements for carbon dioxide (CO2), nitrogen dioxide (NO2), ozone, PM10, and PM2.5: background level, pollutant transport, population exposure, representative concentration, source impact, real time modeling and trend analyses. South Coast AQMD produces reports based upon MATES V data and will continue to update these findings throughout the project period. Through data collection, Cummins, and its participating fleets will provide EPA with operational data to vehicle performance. Detailed performance measures for the 15-liter project include:

Table 8. Output and Outcome Tracking and Measurement Plan

Output	**Tracking Plan**	**Measuring Plan**
Repower diesel trucks with 15-liter NG engine	Request quarterly status updates from Cummins and fleets	Compare actual progress to schedule to determine any deficiencies
Deploy new natural gas trucks (estimated)		
Outcome	**Tracking Plan**	**Measuring Plan**
Annual NOx Reductions (averaged)	Data collector to install data loggers to track agreed upon performance metrics on demonstration vehicles. Request Cummins provide sales figures.	Analyze data based upon approved data collection plan including emission reductions based on actual vehicle miles travelled by fleet vehicles. Report adjusted future sales projections with updated NOx and GHG emissions reductions
Lifetime NOx Reductions (2022-2031)		
GHG Emission Reductions (2022-2031)		

South Coast AQMD, as the project administrator, will monitor Cummins and participating fleets on progress according to the project schedule and through project completion and close-out. South Coast AQMD has effectively and successfully managed several fleets and OEMs on similar projects. Experience includes relevant work deploying battery electric and fuel cell trucks in fleets and administering drayage truck deployment projects such as DOE's Zero Emission Cargo Transport (ZECT) 1 and ZECT 2, CARB's Greenhouse Gas Reduction Fund Zero Emission Drayage Truck (ZEDT) Program and Zero and Near-Zero Emission Freight Facilities Project, and the Daimler battery electric truck project funded by South Coast AQMD, the Ports of Los Angeles and Long Beach, and the EPA.

(3-D) Timeline and Milestones: The detailed project plan is divided into five major tasks: administrative duties, hardware change, Pre-Commercial Demonstration, Emissions/OBD Development and Certification, and monitoring and reporting. The timeline for completion of the project and technical milestones associated with the five tasks are outlined in below. If awarded, Cummins will begin work immediately to ensure the new 15-liter is available for commercial sale by late 2023. All work will be completed by December 31, 2023. South Coast AQMD will monitor and collect operational and performance data from participating fleets for the project duration. This schedule is reasonably adequate to complete proposed project and achieve project goals and objectives.

Figure 8. Visual of Project Plan and Timing

Milestone	**Responsible Party**	**2021**				**2022**				**2023**			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1: Grant Agreement & Outreach													
1.1 Seek Board Approval to recognize grant & award contract	SCAQMD												
1.2 Execute a grant agreement with EPA	SCAQMD												
1.3 Execute contract with Cummins	ALL												
Task 2: Hardware Development													
2.1 12 V changes	Cummins												

2.2 Intake Manifold	Cummins												
2.3 EGR Cooler	Cummins												
2.4 Catalyst	Cummins												
2.5 Transparency Verification	Cummins												
Task 3: Pre-Commercial Field Demonstration													
3.1 Demo Truck Installation	Cummins												
3.2 In-Service Demonstration	Cummins												
3.3 Endurance Test	Cummins												
3.4 Engineering Vehicle Install	Cummins												
Task 4: Emissions/OBD Development & Certification													
4.1 Emissions Development	Cummins												
4.2 OBD Development	Cummins												
4.3 In-Use Emissions Development	Cummins												
4.4 CARB OBD Demonstration Test	Cummins												
4.5 Pre-Certification	Cummins												
4.6 CARB/EPA Certification	Cummins												
4.7 CARB/EPA Cert Approval	Cummins												
Task 5: Monitoring and Reporting													
5.1 Quarterly Reports	ALL												
5.2 Air Quality Benefit Analysis	ALL												
5.3 Final Report	SCAQMD												

Section 4 Programmatic Capability and Past Performance

(4-A&B) Past Performances and Reporting Requirements: During the last ten years, South Coast AQMD has been the prime applicant for dozens of successful, federally co-funded emission reduction projects. The organization's subject matter expertise and project management capabilities ensure that deliverables are completed successfully, and that reporting is complete and timely. Three recent and relevant federally funded projects are in Table 9 below.

Table 9 EPA-Funded Assistance Agreements

EPA Agreement (Agreement Number)	Description	CFDA	Status of Deliverables	Reporting
Diesel Emission Reduction Projects (EM-00T34701-0)	The agreement ($5 million) is to (1) install a shore power infrastructure, (2) replace 25 HDDTs with 2010 compliant HDDTs, (3) replace and demonstrate up to 28 UPS diesel delivery trucks with zero-emission vehicles, and (4) replace 19 older diesel school buses with 2014 or newer natural gas school buses certified to meet 0.2 g/bhp-hr NOx and 0.01 g/bhp-hr diesel PM	66.202	Completed	The program has been completed and a final technical report was submitted to EPA in 2017
Shuttle Bus Replacement (EM-99T71501)	The agreement ($3.2 million) is to replace conventional diesel and gasoline powered shuttle buses with zero emission shuttle buses in Southern California airports	66.202	On-going	Progress reports submitted on a quarterly basis
Daimler Develop Heavy-Duty Trucks with EV Infrastructure (A00909418)	The agreement ($500,000) is to develop 20 heavy-duty battery electric trucks with EV infrastructure and energy storage to demonstrate in real-world commercial fleet operations in DACs	66.001	On-going	Progress reports submitted on a quarterly basis

South Coast AQMD has a long history of successfully collaborating with Basin stakeholders to reduce emissions from a variety of mobile sources and stationary sources. South Coast AQMD is successfully implementing several air quality incentive programs including the VW Settlement, Proposition 1B, the Carl Moyer Program, and the Lower Emitting School Bus Program. Through the Carl Moyer Program, South Coast AQMD has generated 7,954 tons per year of NOx, 294 tons per year of ROG, and 232 tons per year of PM in the South Coast Air Basin, through the allocation of $390 million in State funding. For the Proposition 1B, which entail more than $458 million in State funding, South Coast AQMD spearheaded the deployment of over 6,595 zero and near-zero emission trucks, 25 ships at berth, three pieces of cargo handling equipment, and 20 locomotives, resulting in 42,798 tons of NOx and 1,154.5 tons of PM2.5 in the South Coast Air Basin for Years 1-5. In addition, under the Clean Fuels Program established in 1988, the South Coast AQMD successfully leveraged $321 million in Clean Fuels funding for $1.5 billion in projects, and managed numerous projects to develop, demonstrate and deploy various near-zero and zero emission technologies, as well as research, development, demonstration, and deployment of alternative fuel and clean fuels technologies. Over the past 32 years, South Coast AQMD has collaborated in partnership with other governmental organizations, private industry, academia, and research institutes and interested parties. Furthermore, South Coast AQMD

has and is currently working on several EPA-funded projects, ranging from air monitoring programs to deployments of zero and near-zero emission vehicles. In 2019 alone, South Coast AQMD's Clean Fuels Program executed 76 new and continuing contracts, projects, and studies in collaboration with a wide cross-section of industry partners. In early 2019, South Coast AQMD received a $45 million grant from CARB for the Volvo LIGHTS project in partnership with Volvo to deploy 23 pilot and production Class 8 battery electric trucks. The first five battery electric trucks were delivered to DHE and NFI in January 2020. Other recent examples of South Coast AQMD's successful leadership includes the $40.1 million Zero Emission Drayage Truck Demonstration Program. South Coast AQMD has continuously partnered with Tier 1 suppliers and industry collaboratives, universities, and utilities to pull in the necessary technical and financial resources necessary to advance product development, demonstration, and commercialization of vehicle technologies. South Coast AQMD has successfully partnered with both State and federal agencies as well as regional collaboratives to develop, demonstrate and deploy near-zero and zero emission technologies including two DOE-funded zero emission drayage truck projects to demonstrate various types of electric and hybrid electric drive technologies, an overhead catenary system using wayside power to support cargo transport operations, and a plug-in hybrid truck with a geo-fencing feature to operate in zero emission mode in DACs disproportionately impacted by diesel exhaust.

South Coast AQMD's successful implementation of these past and on-going projects demonstrates that it is preeminently qualified to lead this deployment project. Its dedicated, experienced staff will lead and provide assistance in the following South Coast AQMD efforts: defining the project scope, statements of work, timeline and payment schedule for contractors; directing and assisting administrative and legal staff on negotiating terms and conditions with contractors; executing contracts; performing project management oversight; and authorizing payment upon verification and approval of deliverables. At the request of EPA, staff can provide documentation and additional information of South Coast AQMD resources and abilities to execute this project. Contractors will be responsible for meeting program milestones and supplying all deliverables and reports. The proposed project will be implemented by South Coast AQMD Technology Advancement Office (TAO) and will employ the following approach in anticipating, responding to, and mitigating issues that may arise: 1) set reasonable deadlines; 2) set detailed contingency plans for predictable delays; 3) regularly review the project schedule and deliverables; 4) establish and maintain lines of communication with all team members; and 5) use delays as opportunities to re-think decisions that led to problems, take advantage of changing circumstances, and improve project deliverables. If an unforeseen delay occurs, South Coast AQMD will work with the project team to identify multiple solutions, including updating deadlines, modifying deliverables, and retaining additional resources as needed. To track and measure the project progress, contractors will be required to submit all information required by South Coast AQMD and EPA.

(4-C) Staff Expertise: Resumes for key personnel are included as an attachment with the application. South Coast AQMD's staff has more combined experience managing and administering grants for clean transportation projects than most public agencies in the U.S. South Coast AQMD's portfolio of expertise includes managing EPA grants, preparing and managing awards with commercial fleets, monitoring work progress, and showcasing successful projects. This project will be implemented by a Planning & Rules Manager, Financial Analyst, Air Quality Specialist, Contract Assistant, and Deputy District Counsel. Overseeing the South Coast AQMD team are Drs. Matt Miyasato and Aaron Katzenstein, Deputy and Assistant Deputy Executive Officers, respectively for Science & Technology Advancement, including the Technology Advancement Office. Dr. Miyasato and Dr. Katzenstein's principal charges are to identify, evaluate and stimulate the development and commercialization of clean air technologies, develop and coordinate mobile source regulations, and conduct ambient monitoring, source testing, and laboratory analysis. Dr. Katzenstein received his doctorate in Atmospheric Chemistry, with twenty years of experience in multiple MATES studies, AQMP's, policy development, research projects, air quality studies, and technology/infrastructure projects. Joseph Impullitti is the Technology Demonstration manager whose duties will include overseeing the Project under the Program Supervisor. He has over 24 years of electric, hybrid, and fuel cell-powered medium- and heavy-duty vehicles/equipment design and development experience as well as supporting infrastructures. He also over 10 years of experience managing demonstration projects funded by the grant programs. Dr. Sam Cao is the Air Quality Specialist who will manage the proposed project. He has over 10 years of industry and academia experience in air pollution and emissions measurement and has managed several RDD&D projects from natural gas to battery electric, advanced technologies for off-road and on-road transportation sources, incentive programs, clean alternative fuel technologies, and retrofit programs. The Contract Assistant will assist the Air Quality Specialist in managing the contract with Cummins and will be selected from a team of Contract Assistants who have managed administrative aspects of RDD&D and incentive programs. The Program Supervisor will work with the Air Quality Specialist to closely manage the project. The Deputy District Counsel will provide legal guidance to the staff throughout the planning and implementation phase of the proposed project.

Section 5 Budget

(5-A) Budget Detail: Most of EPA's funding (95% or $7,600,000) is directed towards the proposed project cost. The South Coast AQMD is leveraging contributions from project partners to provide a substantial voluntary cost share (57%) for the proposed project. South Coast AQMD requests $8,000,000 from the EPA Air Shed Grant Program to fund the proposed project, which is estimated to cost $18,907,000.

Table 10 Itemization of Costs

Line Item and Itemized Cost	EPA	Non-Federal Cost Share
Personnel		
(1) Planning & Rules Mgr (Annual Salary-$75.27/hr; 88.16 Hours)	$6,635.56	
(1) Program Supervisor (Annual Salary-$61.52/hr; 862.88 Hours)	$53,084.44	
(1) AQ Specialist (Annual Salary-$49.25/hr; 1,347.32 Hours)	$66,355.55	
(1) Contract Assistant (Annual Salary-$26.87/hr; 246.95 Hours)	$6,635.55	
Total Personnel	$132,711.10	
Total Fringe Benefits – 64.03% of Salaries. Includes Retirement, Health Benefits, FICA & SUI	$84,974.92	
Total Travel (demo site visits, Cummins visit, conference presentations)	$5,000.00	
Total Other – Subaward/subgrant to Cummins Inc. for development, demonstration, and certification of 15-liter natural gas engine	$7,600,000	$10,907,000
Total Indirect (81.45% applied to Salaries & Employee Benefits)	$177,313.98	
Total Funding	**$8,000,000**	**$10,907,000**
Total Project Cost (Federal and Non-Federal)	**$18,907,000**	

As shown in Table 10 above, project partners will together provide $10,907,000 in voluntary cost share for the proposed project as outlined in the commitment letters attached. To ensure that the sub-awardee provides the committed mandatory cost share, South Coast AQMD will only reimburse sub-awardee upon receipt of valid invoice that includes the total expenditure with proper documentation as each task is completed and required report is submitted. This budget is sufficient to accomplish the proposed goals, objectives, and measurable environmental outcomes.

(5-B) Expenditures of Awarded Funds: The South Coast AQMD staff has extensive experience managing engine and vehicle technology development and demonstration projects. Our highly technical staff has the resources and expertise necessary to successfully implement the proposed project, including drafting a contract with appropriate terms and conditions, detailed task descriptions, and payment schedules tied to milestones to ensure all required tasks have been satisfied before any funds are paid out. In addition, South Coast AQMD will closely monitor the progress of the project via telephone calls, e-mails, meetings and site visits as well as quarterly progress reports provided by the contractors. Invoices are generally processed and paid out within 30 days of the receipt by the South Coast AQMD to ensure projects are not negatively affected by delayed reimbursements.

(5-C) Reasonableness of Costs: The total project cost is estimated to be $18,907,000, of which South Coast AQMD is requesting $8,000,000 from EPA, including administrative costs of $400,000 necessary for South Coast AQMD to implement the project. The requested funds will be used to supplement the costs engine hardware development, emissions and OBD development, pre-commercial truck demonstration and certification activities., see Table 11. Only approximately 5 percent or $400,000 of the requested fund will be allocated for administrative costs and the remaining grant of $7,600,000, along with $10,907,000 of cost share from the non-federal sources, will be allocated for the cost of engine development and project support and reporting cost. If the project is awarded, South Coast AQMD is committed in providing voluntary cost-share up to $1,400,000 toward the proposed project subject to governing board approval. Cummins had multiple contracts with South Coast AQMD and staff has reviewed detailed budget break down of proposed project to ensure reasonableness of the project cost. Table 6 also lists simplified cost effectiveness (CE) calculated using the total project cost and EPA funds for the emissions reductions for SCAB. This project's CE of $22,316.40 per weighted ton of NOx reduced compare to Carl Moyer's $100,000 limit confirms that near-zero natural gas technology remains one of the most cost-effective way for achieving near-term NOx reduction.

Table 11. Detailed Project Budget.

Hardware Development Cost	$ 1,451,000.00
Pre-Commercial Demonstration Cost	$ 4,207,000.00
Emissions/OBD Development and Certification Cost	$ 10,177,000.00
Other Cost (Project Management/Misc)	$ 2,672,000.00
Funds Request for 15L	**7,600,000.00**
Request For SCAQMD Administracion	**400,000.00**
Toral EPA Request	**8,000,000.00**
Total Leveraged (Cummins + SCAQMD)	**$10,907,000**
Project Total Cost	**$18,907,000.00**

6) Attachments

(6-A, B, C, D) Emissions Inventories Analysis**,** Emission Reduction Calculation Descriptions**,** Leverage Funds Cost-Share Commitment and Partnership Letters**,** Resumes